



## CABLE HISTORICAL OPERATING TEMPERATURE ESTIMATOR

Operating Temperature

Thermal Analysis

Distribution Analysis

Transmission Analysis

Switching Optimization

And more...

### CYMCAP/CHOTE

There are many underground (UG) transmission/distribution systems in operation for longer than 50 years (a few even longer than 100 years). Utilities are facing the need to provide reliable service with an aging cable infrastructure. UG system planners and operators currently do not know if (which, where, when and for how long) cables have exceeded, at some point in time, their operating or emergency temperature.

The Cable Historical Operating Temperature Estimator (CHOTE) is a software application that offers an innovative way to evaluate the temperature at which underground cable systems have operated during their in-service life.

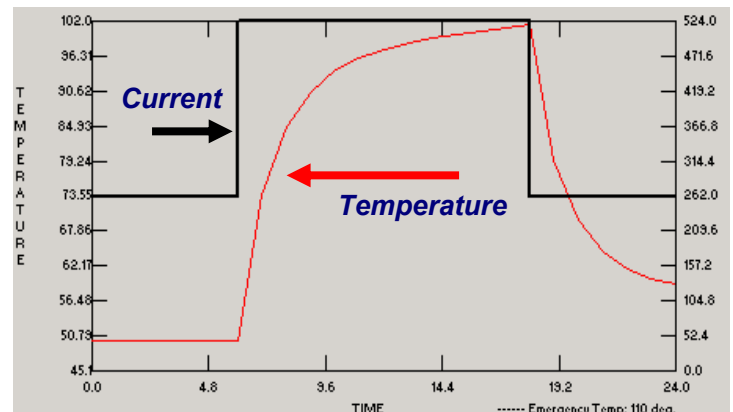
CHOTE provides important information to transmission and distribution engineers. It allows identifying, qualifying and quantifying the following important conditions:

- The cables and cable installations that have been exposed to thermal damage. Say which cables have exceeded their *normal and/or emergency temperatures* during their in-service life.
- For how long and for how much the applied over-temperatures compare with the original design characteristics.

Cable engineers can take advantage of the above information to plan additions and/or substitutions in an informed manner. By using CHOTE an engineer knows for how long each cable has exceeded a desired certain target temperature. As a consequence, there is valuable information to estimate the remaining life of a cable, which can be used to manage efficiently capital investments in cable installations. For example, an investment to substitute a cable can be postponed, or planned to do it “just in time”, with greater certainty thanks to the information that CHOTE offers.

### Transient Calculations

Cable operating temperature very much depends on the load shape applied to the cable. In other words, the temperature of a cable depends on the intensity of the current and its time variations. Therefore, cables have different ratings, i.e. steady state, cyclic, emergency and short circuit. Since cables installations have thermal inertia, it takes time to heat up the cable and its surroundings. A typical response to a step overload of 100% lasting 12 hours is shown in the figure below. One can appreciate that the temperature of the cable follows in an exponential way the changes in current.

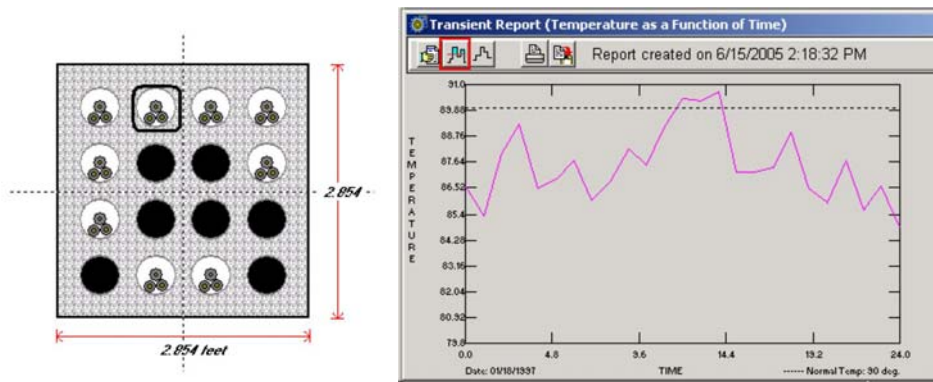


## Application Highlights

Using transient simulations, CHOTE processes archived loading information usually available through the SCADA/PI systems on an hourly (or 15 minutes) resolution. Thus, the input to the temperature estimator is the current of all cables on a particular installation. CHOTE is capable of automatically analyzing all the thermal sections of a system. This may include transmission and even the entire distribution system (manhole-to-manhole). The temperature estimator can process archived information for any length of time. Currently 10 years of historical data are being used.

The output of CHOTE is a list of cable sections that have exceeded the (definable) normal and/or emergency target temperatures. CHOTE produces a global ranking report. The cables that exceed their target (normal/emergency) temperatures for the longest time are given the first place in the report. The output displays not only where, but also when the hot spots have occurred.

CHOTE is capable of indicating the location of the cables that have exceeded a target, either normal or emergency, temperature. It will give the thermal section (manhole-to-manhole), the feeder name, the dates, times and for how long certain temperature was exceeded. Additionally, the application shows graphically the location of the cable with problems in the duct bank and even allows re-creating the condition that produced the temperature problem.



The left-hand side shows the location of the cable exceeding the target temperature of 90°C. On the right-hand side is the re-creation of the cable temperature curve. Note how it exceeds the 90°C target.

CHOTE can perform what-if scenarios to study the impact of addition of new cables. This facility can also be used to determine the remaining ampacity of one or more of the cables installed in a given duct bank.



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